

Application No.: 10/564,984
Amendment under 37 CFR 1.111
Reply to Office Action dated January 30, 2007
June 7, 2007

REMARKS

By this amendment, claims 1-4 have been amended and new claims 5-7 have been added in the application. Currently, claims 1-7 are pending in the application.

Claims 1-4 were rejected under 35 USC 112, second paragraph, as being indefinite. The Examiner believed that claims 1 and 4 were indefinite because of the phrase "cyclic alkyl group having 2 to 20 carbon atoms". The Examiner stated that it was not possible for a cyclic alkyl group to have two carbon atoms. By this amendment, independent claim 1 has been amended to recite "a cyclic alkyl group having 3 to 20 carbon atoms".

The Examiner also stated that claims 2 and 3 were indefinite because the variable R was not defined in the claims. By this amendment, claims 2 and 3 have been amended to recite "R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms".

The Examiner also stated that claim 3 was indefinite because of the phrase "producing the compound according to claim 2". The Examiner believed that claim 2 was not a process claim. By this

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amendment, claim 3 has been amended into an independent compound claim to recite a phosphetane compound used as an intermediate of a diphosphetane compound. It is respectfully submitted that this rejection has been overcome by this amendment and it should be withdrawn.

Claims 1-4 were rejected under 35 USC 102(b) as being anticipated by Imamoto et al. (Optically Active 1,1'-Di-tert-butyl-2,2'-diphosphetanyl and Its Application in Rhodium-Catalyzed Asymmetric Hydrogenations).

This rejection is respectfully traversed for the following reasons.

PCT International Application No. PCT/2004/010670, which is the priority application for this application, was filed on July 27, 2004, and claimed foreign priority to Japanese Patent Application No. 2003-280584 filed on July 28, 2003. Applicants respectfully submit that this U.S. application is an exact translation of the PCT application and also of Japanese Patent Application No. 2003-280584. Applicants also respectfully submit that all of the presently claimed features of claims 1-4 were disclosed in Japanese Patent Application No. 2003-280584. Since the filing date of the foreign priority application of the present

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invention (July 28, 2003) is earlier than the publication date of Imamoto et al. (August 6, 2004), applicants respectfully request the Examiner to withdraw this rejection when acting on this Amendment.

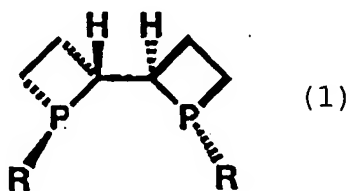
Claims 1-4 were rejected under 35 USC 102(b) as being anticipated by Zhang et al. (WO 2003042135, and U.S. Patent No. 7,153,809). Also, claims 1 and 4 were rejected under 35 USC 103(a) as being obvious over Zhang et al.

These rejections are respectfully traversed in view of the remarks below.

The present invention relates to a novel optically active phosphorus-chiral diphosphetane compound, an intermediate therefore, and a transition metal complex having the compound as a ligand (see page 1, lines 6-9 of the specification).

The present invention discloses that in a first aspect of the present invention, there is provided an optically active diphosphetane compound represented by formula (1):

[Chem. 2]

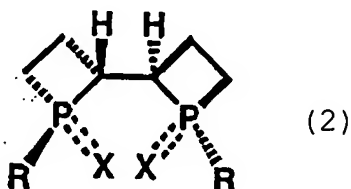


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(wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms).

In a second aspect of the present invention, there is provided a diphosphetane compound represented by formula (2):

[Chem. 3]

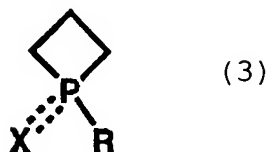


(wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and == represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom).

In a third aspect of the present invention, there is provided a phosphetane compound used as an intermediate for producing the diphosphetane compound represented by formula (2), the phosphetane compound being represented by formula (3):

[Chem. 4]

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(wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and == represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom).

In a fourth aspect of the present invention, there is provided a transition metal complex including the optically active diphosphetane compound represented by formula (1) as a ligand (see page 4, line 8 - page 5, line 18 of the specification).

The present invention also discloses that an example of a process for producing the optically active phosphorus-chiral diphosphetane compound is represented by the reaction formula [Chem. 8] (see page 15, lines 15-16 of the specification).

The present invention also discloses that the compound of formula (3) can be produced by a first step in which monoalkylphosphine (A) used as a raw material is reacted with 1,3-propanediol ester, 1,3-dihalogenylpropane, or 1,3-propanediol

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cyclic sulfate and then reacted with a borane complex, an oxidizing agent, or a sulfurizing agent. The compound of formula (2) can be produced by a second step of coupling the compound of formula (3). The compound of formula (1) can be produced by a third step of removing borane, oxygen, or sulfur from the compound of formula (2).

In the first step, monoalkylphosphine (A) is reacted with 1,3-propanediol ester, 1,3-dihalogenylpropane, or 1,3-propanediol cyclic sulfate in the present of tert-butyl lithium and then reacted with a borane complex, an oxidizing agent, or a sulfurizing agent. The monoalkylphosphine used as a raw material is a compound in which one hydrogen of the phosphine is substituted by a linear or branched alkyl group having 2 to 20 carbon atoms (see page 15, line 17 - page 16, line 17).

Independent claim 1 recites "An optically active diphosphetane compound represented by formula (1): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms)".

Also, independent claim 2 recites "A diphosphetane compound represented by formula (2): (wherein R represents a linear or a

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branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and === represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom)".

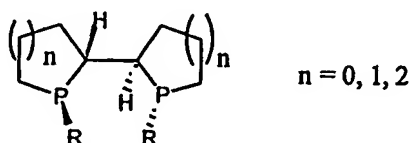
Also, independent claim 3 recites "A phosphetane compound used as an intermediate of a diphosphetane compound, the diphosphetane compound represented by formula (2): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and === represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom); and the phosphetane compound being represented by formula (3): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and === represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom)".

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Also, claim 4 has been amended to recite "wherein the optically active diphosphetane compound is comprised in a transition metal complex as a ligand". These features are not shown or suggested by Zhang et al.

Zhang et al. relate to novel chiral ligands derived from P-chiral phospholanes and P-chiral phosphocyclic compounds and catalysts for applications in asymmetric catalysis. More particularly, Zhang et al. relates to transition metal complexes of these chiral phosphine ligands, which are useful as catalysts in asymmetric reactions, such as, hydrogenation, hydride transfer, hydrocarboxylation, hydrosilylation, hydroboration, hydrovinylation, hydroformylation, allylic alkylation, olefin metathesis, isomerization, cyclopropanation, Diels-Alder reaction, Heck reaction, Aldol reaction, Michael addition, epoxidation, kinetic resolution and [m + n] cycloaddition (see page 1, lines 11-20).

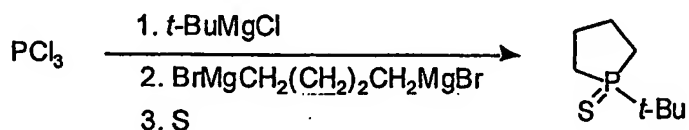
Zhang et al. disclose the chiral ligand can be represented by the formula and its enantiomer:



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Wherein R can be alkyl, aryl, substituted alkyl, substituted aryl, heteroaryl, ferrocenyl, alkoxy and aryloxy; and wherein n is from 1 to 2; R can be CH₃, Et, iPr, t-Bu, 1-adamantyl, Et₃C, cyclo-C₅H₉, cyclo-C₆H₁₁, phenyl, p-tolyl, 3,5-dimethylphenyl, 3,5-di-t-butyl phenyl, ortho-anisyl and naphthyl (see page 12, lines 5-13).

Zhang et al. also disclose (1) Synthesis of TangPhos using asymmetric deprotonation:



Zhang et al. do not disclose an optically active diphosphetane compound represented by formula (1): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms) as claimed in independent claim 1.

Zhang et al. also do not disclose a diphosphetane compound represented by formula (2): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and ===

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represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom) as claimed in independent claim 2.

Zhang et al. also do not disclose a phosphetane compound used as an intermediate of a diphosphetane compound, the diphosphetane compound represented by formula (2): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and == represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom); and the phosphetane compound being represented by formula (3): (wherein R represents a linear or a branched alkyl group having 2 to 20 carbon atoms or a cyclic alkyl group having 3 to 20 carbon atoms, X represents a boron trihydride group, an oxygen atom, or a sulfur atom, and == represents a single bond when X is a boron trihydride group or a double bond when X is an oxygen atom or sulfur atom) as claimed in independent claim 3.

Zhang et al. also do not disclose the optically active diphosphetane compound is comprised in a transition metal complex as a ligand as claimed in claim 4.

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Applicants respectfully submit that none of examples 1-10 in Zhang et al. discloses a squared cyclic structure compound formed by 3 carbon atoms and 1 phosphor atom as claimed in the present invention because Zhang et al. use the following Grignard reagents: $\text{BrMgCH}_2(\text{CH}_2)_2\text{CH}_2\text{MgBr}$ (4 carbon atoms) to make a cyclic structure of the compound. In fact, it is well known that there is difficulty in making a Grignard reagent having 3 carbon atoms and a reactant point on both sides of the chain in this technical field. Specifically, in Zhang et al., if a squared cyclic structure compound including 3 carbon atoms and 1 phosphor atom was made by using Grignard reagent, the Grignard reagent must have the following structure: $\text{BrMg}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{MgBr}$. However, to obtain this Grignard reagent, the following compound: $\text{Br}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{Br}$ has to react with magnesium, and when the alkyl chain is short carbon chains (3 carbon atoms in this case), magnesium is difficult to connect to both sides of the chain. Even if a Grignard reagent having 3 carbon atoms and reactant point on both sides of the chain was made, it would have a low yield with a lot of impurities so that this compound would not be useful for producing a squared cyclic structure compound as claimed in the present invention.

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Also, applicants respectfully submit the article "Di-Grignard reagents and metallacycles" enclosed in the Information Disclosure Statement filed with this amendment. This article discloses that the traditional and most convenient way to prepare Grignard reagents is from organic halides and magnesium metal in a basic, aprotic solvent. For di-Grignard reagents (1), this method is applicable in a straightforward way only when at least 4 (aliphatic) carbon atoms separate the two functions (see page 537, paragraph 1 of the INTRODUCTION). Also, this article discloses di-Grignard reagents with short carbon chains containing less than four aliphatic carbon atoms. However, this di-Grignard reagents has low yield (e.g., 30%) and low purity (see paragraph "III 1,3-Grignard reagents" on page 539) so that it is not useful for producing the presently claimed compound as discussed above.

On the other hand, the present invention discloses that the compound of formula (3) can be produced by a first step in which monoalkylphosphine (A) used as a raw material is reacted with 1,3-propanediol ester, 1,3-dihalogenylpropane, or 1,3-propanediol cyclic sulfate and then reacted with a borane complex, an oxidizing agent, or a sulfurizing agent. The compound of formula (2) can be produced by a second step of coupling the compound of

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formula (3). The compound of formula (1) can be produced by a third step of removing borane, oxygen, or sulfur from the compound of formula (2). Accordingly, the presently claimed compound has a squared cyclic structure compound formed by 3 carbon atoms and 1 phosphor atom and is produced without using Grignard reagents.

It is therefore respectfully submitted that Zhang et al. do not teach, disclose or suggest the presently claimed invention and it would not have been obvious to one of ordinary skill in the art to make the presently claimed invention.

New independent claim 5 has been added in the application. Applicants respectfully submit that new claim 5 has been added to recite "wherein the phosphetane compound represented by formula (3) is 1-boranato-1-tert-butyl-phosphetane". Applicants respectfully submit that this additional feature of new independent claim 5 also defines over the prior art of record. Therefore, allowance of new independent claim 5 is also respectfully requested.

New independent claim 6 has been added in the application. Applicants respectfully submit that new claim 6 has been added to recite "wherein the diphosphetane compound represented by formula (2) is (1S, 1S', 2R, 2R')-1,1'-diboranato-1,1'-di-tert-butyl-

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[2,2']-diphosphetane". Applicants respectfully submit that this additional feature of new independent claim 6 also defines over the prior art of record. Therefore, allowance of new independent claim 6 is also respectfully requested.

New independent claim 7 has been added in the application. Applicants respectfully submit that new claim 7 has been added to recite "wherein the transition metal complex is one of [rhodium (I) ((1S, 1S', 2R, 2R')-1,1'-di-tert-butyl-[2, 2']-diphosphetane)(norbornadiene)] tetrafluoroborate or [rhodium (I) ((1S, 1S', 2R, 2R')-1,1'-di-tert-butyl-[2, 2']-diphosphetane)(norbornadiene)] hexafluorophosphate". Applicants respectfully submit that this additional feature of new independent claim 7 also defines over the prior art of record. Therefore, allowance of new independent claim 7 is also respectfully requested.


In view of foregoing claim amendments and remarks, it is respectfully submitted that the application is now in condition for allowance and an action to this effect is respectfully requested.

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If there are any questions or concerns regarding the amendments or these remarks, the Examiner is requested to telephone the undersigned at the telephone number listed below.

Respectfully submitted,

Date: June 7, 2007


Randolph A. Smith
Reg. No. 32,548

SMITH PATENT OFFICE

1901 Pennsylvania Ave., N.W.,
Suite 901
Washington, DC 20006-3433
Telephone: 202/530-5900
Facsimile: 202/530-5902
Oohara060707